VTM
User's Manual
As of version: V.09.10.00

Küppers Elektromechanik GmbH
Quality system certified to DIN EN ISO 9001

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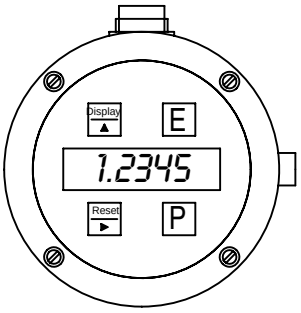
1. General

1.1 Application



The VTM is a programmable local display with integral carrier-frequency pickup and amplifier for KEM flow meters. It serves the evaluation of flow volumes. Measuring results are indicated in an 8 digit LCD display with 14 segments. The pulse output provides a flow-proportional frequency signal or scaled volume pulse in accordance with programming. Optionally the measuring signal may be scaled in a 4-20 mA current loop.
The display is available in two different arrangements to fit various installing positions (see drawing p. 6). The electronic housing is slewable by 360°, in addition the display unit may be positioned in steps of 90° (see p. 22). These features guarantee for an excellent readability independent of the installing position.
For electrical connection a 6-pin plug or a junction box with 6 internal terminals is provided.

1.2 Ordering Information

VTM * * * * * Ex

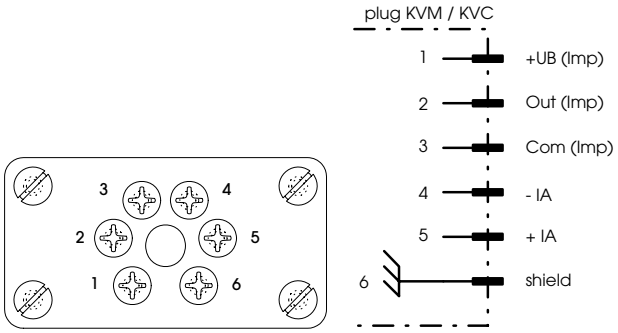
Ex-protection	Ex = Ex-protection ATEX 100a EX II 2 G EEx ia IIC T4
electrical connection	K = junction box
cover	S = protective cover with glass window
pickup	K = for ZHM 02 to 04 and HM series R = for ZHM 01, 01/1 and 01/2 as well as SRZ series S = centre pickup for ZHM series
display arrangement	D = top view
signal output	B = frequency output/divider and analogue output

2. Specifications

2.1 Technical Data

General

LCD display:	8 digits (14 segments), digit height 7 mm for real-time value, totals and programming, slewable in steps of 90° after losening the fixing screws
ambient temperature:	–40 up to +70 °C
medium temperature:	–40 up to +120 °C with a distance of at least 25 mm between flow meter and electronic housing
electrical connection:	junction box with 6 internal terminals



Ex-protection ATEX 100a:	EX II 2 G EEx ia IIC T4, BVS 03 ATEX E 205 safety-relevant data as per Ex-certificate
protection class:	IP 65
housing:	aluminium AlMgSiPb, blue anodised, slewable by 360°

Frequency output/divider

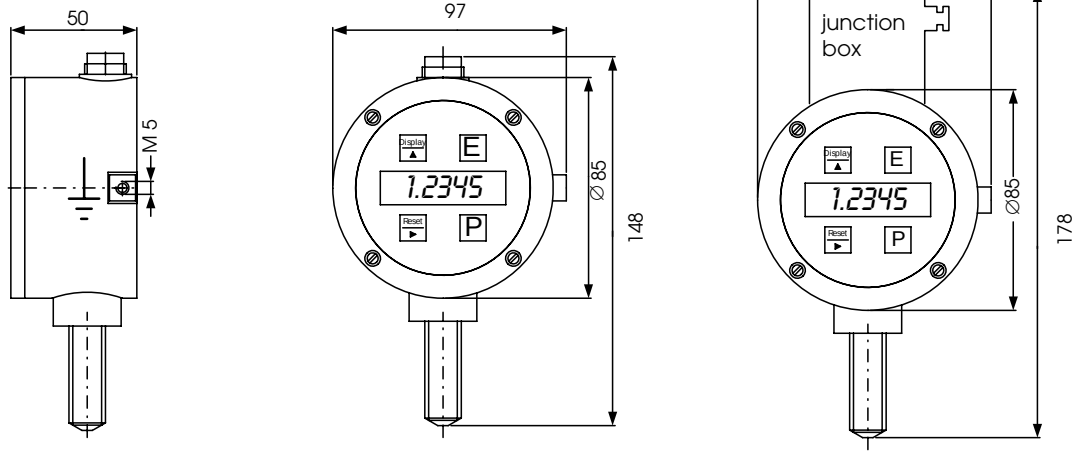
operating mode:	3-wire
supply voltage:	8–30 V DC controlled
quiescent current (IR):	< 25 mA
signal output:	push/pull Imax: 20 mA
1.	frequency output: fmax: 3,000 Hz duty cycle: approx. 1:1
2.	divider: pulse width: 1 ms, 20 ms, 50 ms fmax: 500 Hz

Analogue output

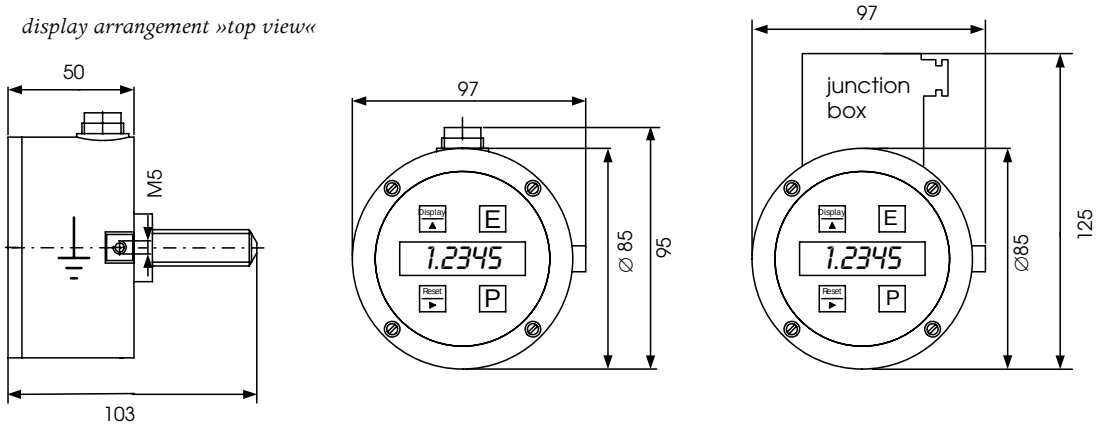
operating mode:	2-wire (4–20mA)
supply voltage:	14–30 V DC controlled UB = (Rload x 20 mA) + 14 V
load:	< 800 Ω
resolution:	12 bit (3,9 µA)
time constant:	slow or fast (programmable under "A-TIME")
signal output:	4–20 mA

2.2 Dimensional drawings (mm)

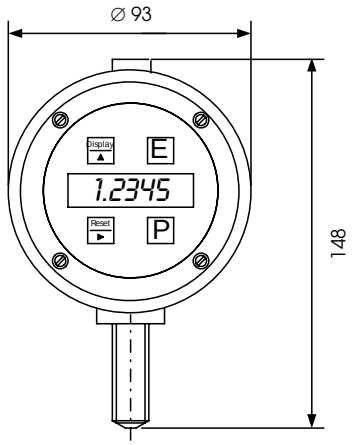
display arrangement »front view«



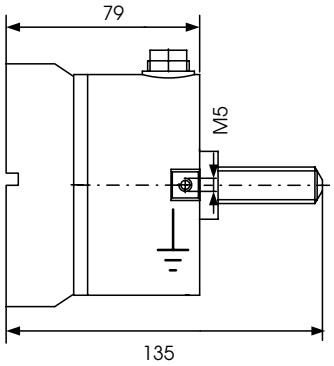
display arrangement »top view«



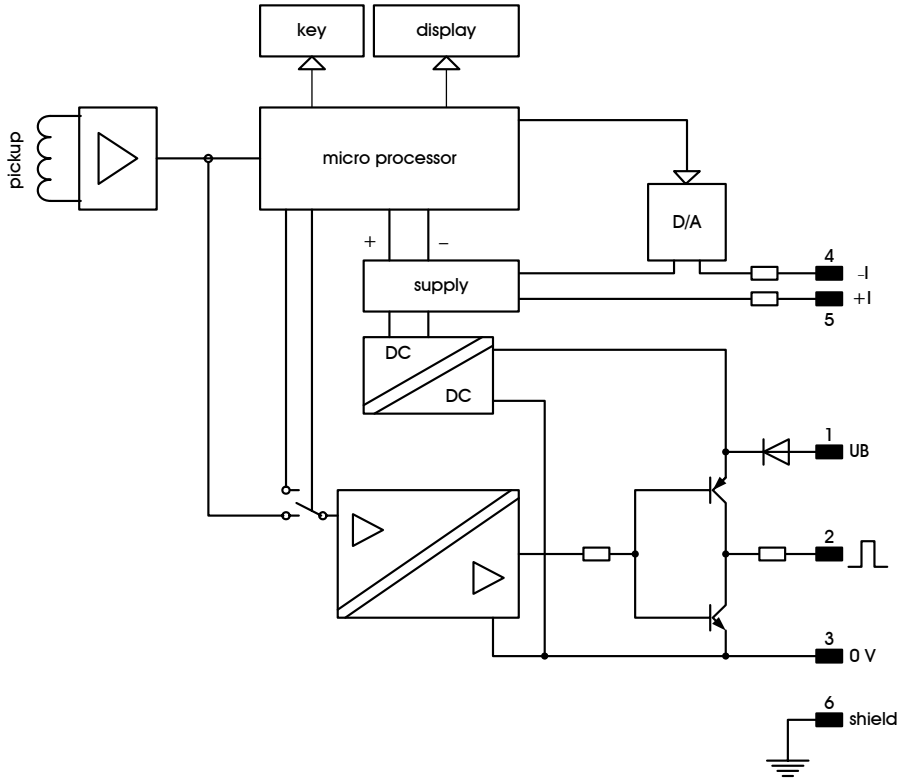
»front view« with protective cover



»top view« with protective cover



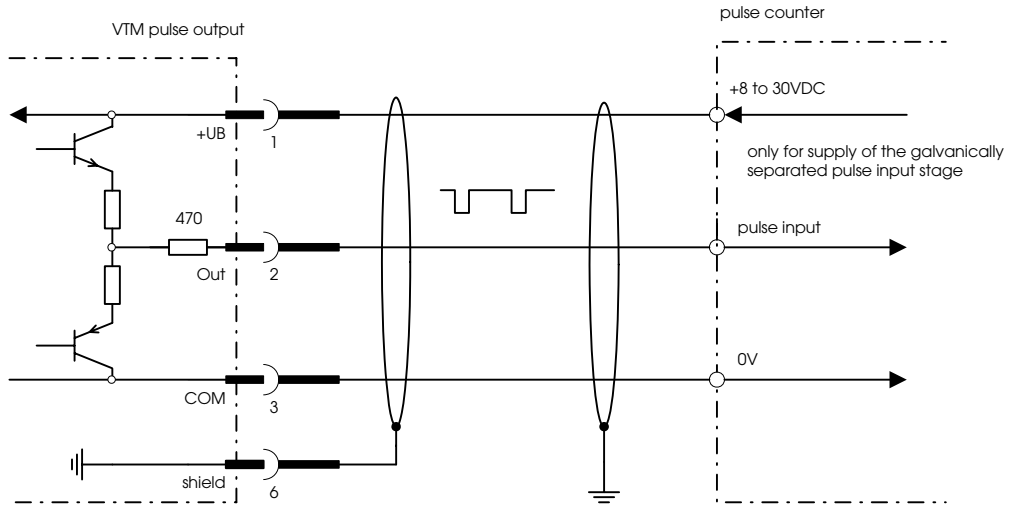
2.3 Functional diagram



2.4 Outputs

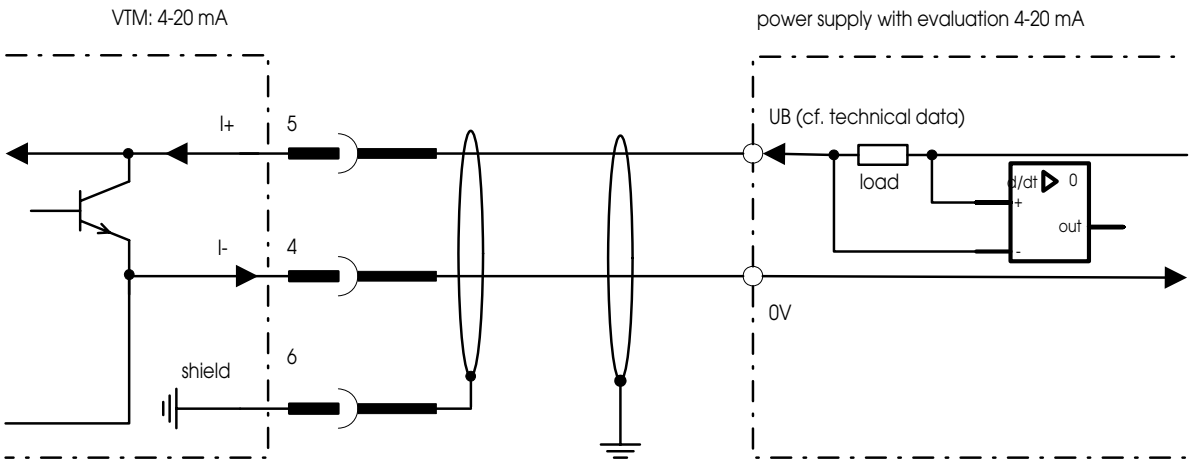
2.4.1 Pulse output

The VTM may optionally be equipped with a pulse output which can either provide standardised pulses (e.g. in m³) or the direct measuring frequency of the flow meter (programmable via parameter *IMP-OUT*). The wiring is as follows:



2.4.2 Analogue output 4–20 mA

The primary current of 4 mA powers the entire electronic of the VTM. The measuring signal of up to 16 mA is added resulting in a current consumption of 4 to 20 mA. The wiring may be taken from the scheme below:



2.5 Notes on installation

Connect metal housing with PE

Built-in devices have to be installed in a metal housing connected with protected earth.
Observe a low impedance connection of PE and a measurement of the PE resistor according to VDE 0701. Also observe a sufficient shielding for the employed cabinet.

Keep distance

Keep current-carrying cables at least 30cm away from the VTM. Only shall indicated terminals and contacts be used for power supply. Keep mobiles, ISM-units or switching inductivities like engines or solenoid valves at least 2 metres away from the digital measuring and control electronics. Avoid sources of electrostatic charges in the closer environment of the VTM. Operators should also consider appropriate clothing and wear of shoes with discharging ability.

Avoid parallel arrangement of current-carrying cables

3. Start up

After connecting the power supply the following messages will appear in the display:

READ-DAT	All outputs take a neutral state. Parameters in the E are being read.
VTM	Type
V-22.07.99	Software version
TEST REG	Calculation of all working parameters.
OKAY	On successful check of all data the VTM will automatically activate the meas uring mode and display the current operational parameters in accordance with the selected measuring mask.

Please note

P-ERROR	Parameter are saved twice in different banks of the EEPROM. In case of deviations between both parameter banks the display will show an error message.

Press [E] to restore all defaults and reset the totaliser to 0000. Afterwards the operation software will start the programming mode and parameter settings may be repeated.

Please note:
The restoring of defaults may be started manually at any time (cf. programming of parameter CLEAR).

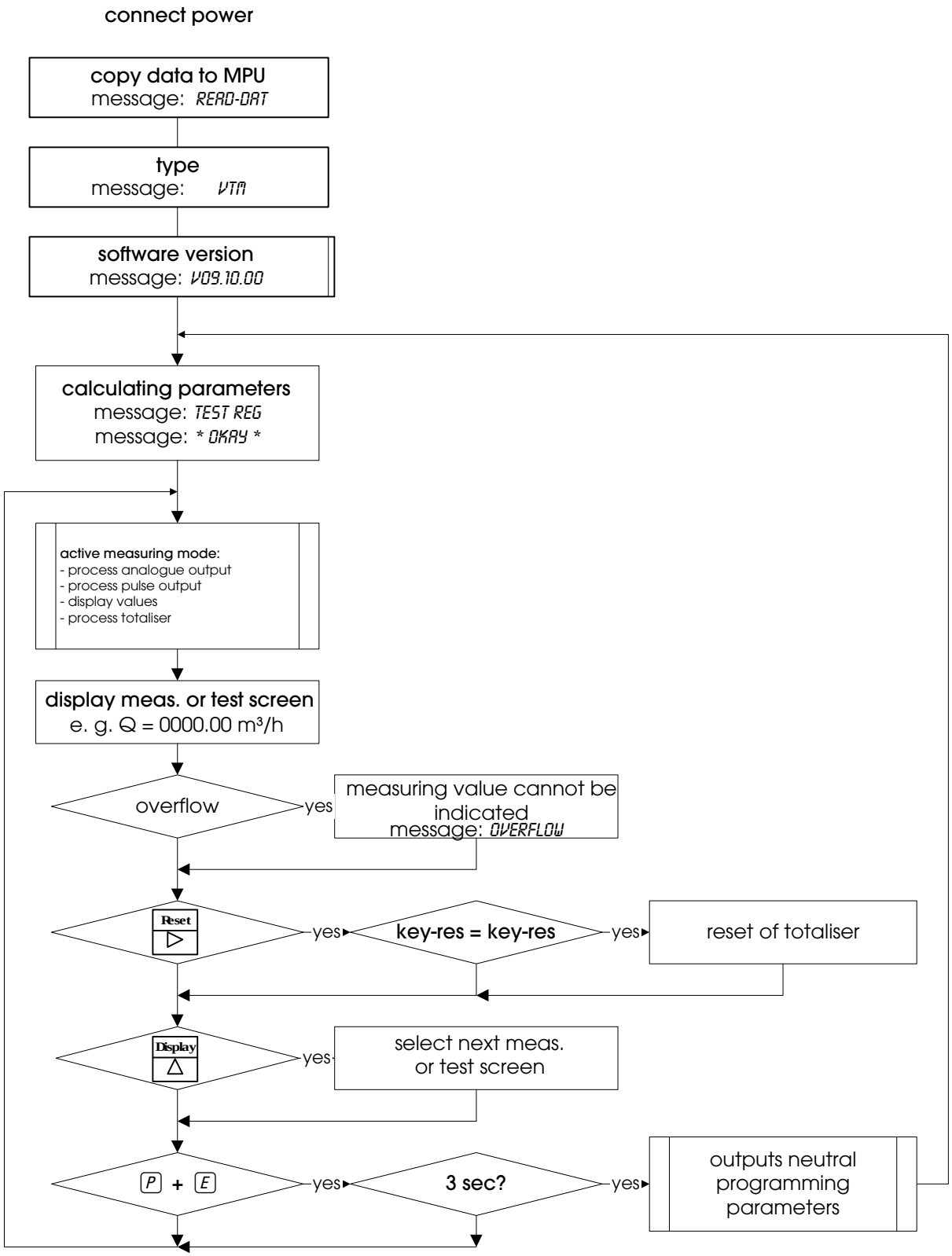
3.1 Error and status messages

During the measuring mode of after programming the following messages may appear in the display:

Message	Description
CLEAR	erasing EEPROM/data memory
P-ERROR	parameter error in EEPROM, proceed with [E]
OVERFLOW	display range exceeded, measuring value cannot be indicated
SET.DEF	set defaults in MPU-RAM
W	cut off frequency passed
READ-DAT	copying data to MPU-RAM
TEST-REG	calculating operational parameters
WRITE	writing data in EEPROM

3.2 MPU programme flow chart

The scheme shows the job stream of the MPU unit and the operation facilities during the measuring mode considering the parameters *KEY-RES* and *DIS-MODE*.



4. Measuring mode

The measuring mode allows for indicating either real-time values or totals. Press [↑] to select the desired measuring mask. On the furthest left-hand digit your selection is indicated by a *Q* for real-time value or *V* for totals. The way of indication (decimal point, flow rate unit etc.) depends on the adjustments in level *PARAMET*.
In case the special character *W* should appear right to the display description (*Q* or *V*), the cut off frequency, parameter *F-CUT*, has been passed.

For start up or test purposes the display mode may be changed to test mode by programming the parameter *DIS-MODE* to *TEST-MOD* (cf. p. 19). In the test mode the display may indicate up to 10 different measuring masks as listed in the table below.

4.1 Measuring masks

Meas. mask	Display	Unit (not displayed)	Start up *DIS-MODE = TEST-MOD*	Meas. mode *DIS-MODE = MESS-MOD*
Q	real time value	flow rate unit	yes	yes
V	totals	flow rate unit	yes	yes
2	direct meas. frequency	000.0 Hz	yes	no
3	gate frequency	000.0 Hz	yes	no
4	direct transmitter pulses	pulses	yes	no
5	D/A value	decimal (0..4095)	yes	no
6	analogue out factor	none	yes	no
7	divider	pulses	yes	no
8	K-factor	flow rate unit	yes	no
9	programming counter	none	yes	no

4.1.1 Real-time value (measuring mask Q)

The real-time value is indicated in accordance with the adjusted flow rate unit *FLOW-DIM* and decimal point position *FLOW-DP*. The calculation is based on the currently measured frequency and the K-factor of the flow meter. The calculation is upgraded every 0.5 sec corresponding to approx. 2 Hz. The internal upgrading and resultant response time of the analogue output and divider depends on the parameters *GATE-TIME* and *A-TIME*.

4.1.2 Totals (measuring mask V)

The integral totaliser of the VTM adds the transmitter pulses standardised in the adjusted flow rate unit (*FLOW-DIM*). Thus flow rates over a long period of time may be detected. The decimal point position depends on the adjusted flow rate unit. The VTM will automatically display totals as accurate as possible.

Example: flow rate unit = m^3/h. Totals are indicated in m^3, e. g. *12.345 M³*

If the measuring value exceeds the display range, it will be assigned accordingly (e. g. 1234.567m^3will be display as 1234.56m^3). If the measuring value is too high to be displayed by fading out digits, it will be displayed using exponential notation (e. g. 1234567.89m^3 will be displayed 1.23E06).

The totaliser may be reset via key provided that the parameter *KEY-RES* is programmed accordingly.

The following masks are only available in the test mode of the display (cf. p. 18)

4.1.3 Direct measuring frequency (measuring mask 2)

With start up or service requirements it may be of advantage to indicate the transmitter frequency. Select mask 2 pressing [↑] (wait until the code »2« appears in the left hand section of the display). The direct measuring frequency is indicated with resolution of 1/10 Hz, i. e. *0000.0*.

4.1.4 Gate frequency (measuring mask 3)

With the *GATE-TIM* parameter you may define a measuring period and the frequency measuring result will be a mean value over this period. Select mask 3 pressing [↑] (wait until the code »2« appears in the lefthand section of the display). The gate frequency is indicated with a resolution of 1/10 Hz, i. e. *0000.0*.

4.1.5 Direct transmitter pulses (measuring mask 4)

This measuring mask shows the unscaled transmitter pulses in the format *000000*. The mask may be used for calibrations on site or reference measurements. When the number of pulses exceeds the display range of 6 digits, this mask will behave like the measuring mask V »totals« (cf. p. 10).
The totaliser may be reset via key provided that the parameter *KEY-RES* is programmed accordingly.

4.1.6 D/A value (measuring mask 5)

This measuring mask shows the decimal value of the D/A-converter, which is derived from the measuring frequency and scaling. The D/A-converter has a resolution of 12 bit corresponding to 4,095 steps of resolution for 16 mA(4-20 mA). The display shows *0000* corresponding to 4 mA and *4095* corresponding to 20 mA.

Example: With 6,000 m³ the analogue output provides 20mA (16 mA modulated + 4 mA primary current). The display will show *4095*.
If the actual flow is 3,000 m³, the display will show *2048* corresponding to 8 mA modulated current + 4 mA primary current. The analogue output provides 12 mA.

4.1.7 Analogue out factor (measuring mask 6)

This mask shows the internal analogue scaling factor, which is calculated by the ratio of the converter resolution (12 Bit = 4095) and the frequency which corresponds to 20 mA. This frequency is calculated considering K-factor, flow rate unit, decimal point and the analogue full scale value.

Example: Frequency with analogue full scale of 6,000 m³/h = 234.56 Hz
Calculation: 4095 : 234.56 Hz = 17.458; i. e. with each Hz the D/A-converter will be increased by 17,458 steps which is displayed in measuring mask 6.

4.1.8 Divider in direct transmitter pulses (measuring mask 7)

The programmed dividing factor in flow rate unit is converted into measuring pulses via the parameter *K-FACTOR*. This mask shows the number of transmitter pulses corresponding to one divider pulse.

Example: K-factor = 835.21 pulses/m³: dividing factor = 0.130 m³
Divider pulses = 835.21 Imp/m³ x 0.130 m³ = 108.577 pulses → display = *109*

4.1.9 K-Factor in programmed unit (measuring mask 8)

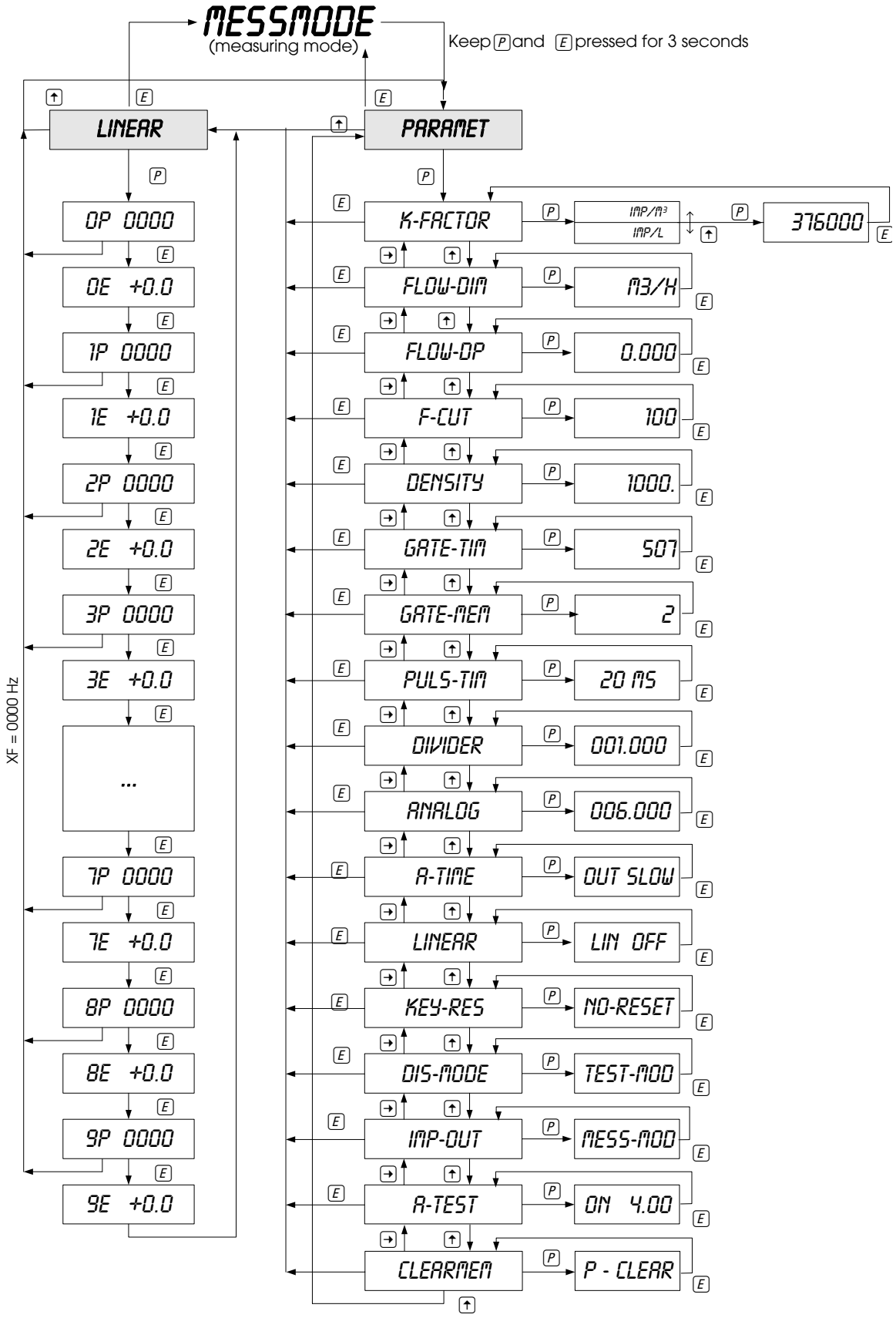
The *K-FACTOR* defines the calibration factor of the VTM, which can be found in the calibration record.
The K-factor is usually stated in pulses/volume unit (e. g. 376000 pulses/m³). In this mask you can see the K-factor converted in accordance with the programmed flow rate unit.

Example: K-factor = 376000 Imp/m³, flow rate unit = gal/h → volume unit gal (US)
376 Imp/dm³ x 3.7854 dm³/gal = 1423.31 Imp/gal → display: *1423.31*

4.1.10 Programming counter (measuring mask 9)

This counter registers how often the programming mode has been started. You may use this to check, whether parameters have been changed since the last programming.

5. Programming

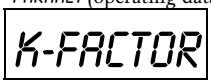


5.1 Starting the programming mode

Simultaneously press [P] and [E] for 5 seconds to start the parameter programming.
The measuring mode will be interrupted and all outputs take a neutral state. The display shows the first parameter level:

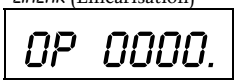
Pressing [↑] you may select from the levels *PARAMET* (operating data) and *LINEAR* (linearisation).
Press [P] to select the first parameter of the selected level.

1st parameter of level *PARAMET* (operating data)



or

1st parameter of level *LINEAR* (Linearisation)



Press [↑] to scroll the parameters of the level.
Press [P] to start programming.

Having started the programming, the display shows the current value of the parameter. It may be adjusted by entering either numericals or selecting from presets.

5.2 Entering numericals

When a numerical parameter appears in the display the up right-hand digit will flash asking you to enter a value.

[→] to select the decimal position. The present position is flashing.

[↑] each pressing will increase the value by 1 (0, 1, 2, 3 ...9, 0, 1).

[P] depending on the parameter each pressing will move the decimal point by one digit in lefthand direction

[E] to save the adjustment. Afterwards the display shows the parameter name again.

[↑] to select the next parameter. [P] to start programming.

[E] to quit the programming mode.

5.3 Selecting from presets

For some parameters, e. g. flow rate unit, you may select from presets. Having selected such a parameter you may scroll the presets pressing [↑]. When the suitable unit appears save with [E].
The parameters concerned and their respective presets can be found from page 16 onwards.

5.4 Level *PARAMET*: operational parameters

5.4.1 Table of parameters

A detailed description can be found on the following pages.

Parameter	Description/Function	Unit	Default
K-FACTOR	K-factor of the flow meter	pulses/m³ or l	*376000.*
FLOW-DIM	flow rate unit	m³/h	*M³/H*
FLOW-DP	flow decimal point	none	*0.000*
F-CUT	cut off frequency	Hz	*100*
DENSITY	specific gravity of the medium	kg/m³	*1000.*
GATE-TIM	gate time/measuring time	ms	*507*
GATE-MEM	memory depth	none	*2*
PULS-TIM	pulse time of divider output	ms	*20*
DIVIDER	divider	m³	*1.000*
ANALOG	analogue full scale	m³/h	*6.000*
A-TIME	response time analogue output	none	*OUT-SLOW*
LINEAR	linearisation on/off	none	*LIN OFF*
KEY-RES	totaliser reset via keyboard	none	*NO-RESET*
DIS-MODE	display mode during measuring mode	none	*MESS-MOD*
IMP-OUT	source for the pulse output	none	*DIVIDER*

5.4.2 Invalid programming

Invalid values or values which are not included in the respective range will be erased after pressing [E]. Afterwards the last value will re-appear in the display and you repeat programming.

5.5 Parameters

5.5.1 *KFACTOR*: K-factor of the flow meter

Each flow meter is supplied with a calibration record indicating the mean K-factor. This factor defines the no. of pulses per volume unit (m³) over the entire measuring range of the flow meter. The linearity error of the mean K-factor over the entire measuring range is also shown in the calibration record.
In addition to the mean K-factor and error, the calibration record does also include K-factors and errors at certain flow rates. With constant flow rates you may reach a higher accuracy by selecting the K-factor which is the closest to the flow rate in your application.

Select the desired unit (m³ or l) via [↑] and confirm with [E]. The K-factor will be entered in pulses per litre or pulses per m³. Enter the number for each position via the [↑] and [→] key. The decimal point may be moved via the PROG key. Press [E] to save.

5.5.2 *FLOW-DIM*: flow rate unit

Your selection will apply for the real-time value and totals as well as the scaling of the indicated value, analogue output and pulse divider. The unit itself is not indicated. You may select from the 15 presets which can be scrolled via [↑]. Press [E] to save and proceed. Respective stickers which may be fitted on the VTM are included.

Preset	L/MIN	L/H	U/MIN	KG/MIN	KG/H	G/MIN	G/SEC	GAL/MIN	GAL/H	LB/MIN	LB/H
operation	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]

preset	M³/MIN	M³/H	CC/MIN	CC/SEC
operation	[↑]	[↑]	[↑]	[↑]

Example: Flow rate unit is l/min. The real-time value is indicated in ltr./min and totals in litres. Programming of the analogue full scale and pulse divider are effected in ltr/min and litres respectively.

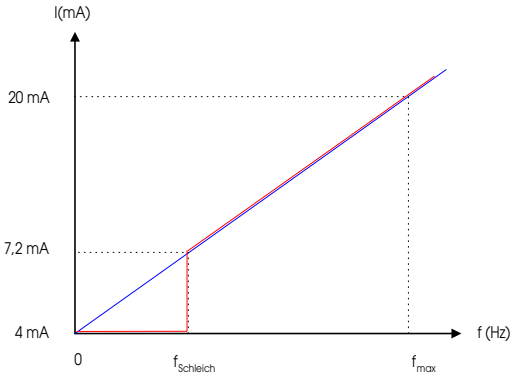
5.5.3 *FLOW-DP*: Flow decimal point

The adjustment applies for the indication of real-time values.

decimal point	0000.	000.0	00.00	0.000
meaning	1/1	1/10	1/100	1/1000
operation	[→]	[→]	[→]	[→]

5.5.4 *F-CUT*: Cut off frequency

When the flow rate bypasses the minimum flow range of the flow meter, the output frequency will be outside the linear range of the meter. The frequency corresponding to the minimum flow range (see calibration record) is called »cut off frequency«. The analogue output, display and limits will not work below this frequency. The analogue output takes its offset value, the real-time values are display 0000 and the limits are out of operation.
The decimal point position for the cut off frequency is fixed to 000.Hz. Press [↑] to programme the value for each digit. Press [→] to move and [E] to save.



5.5.5 *DENSITY*: Specific gravity of the measuring medium

In case a mass-related unit was selected for the flow rate, you may enter the density of the measuring medium in kg/m³ and the MCM will calculate the measuring values considering the K-factor and density. The decimal point may be moved via the [P] key.
Please note, when a volumetric unit (e. g. ltr/min) was selected for the flow rate, the VTM will skip the density programming.

5.5.6 *GATE*: Gate time/Measuring time

The parameter »gate time« enables you to adapt the temporary transmission behaviour between frequency and analogue output to your requirements.
After the gate time has passed, the VTM calculates an average frequency for the measuring interval thereby calming signal fluctuations.

Periodic disturbances, e. g. pressure fluctuations, will be included in the displayed values, if the gate time is too short. You may avoid this by choosing an appropriate interval.

Example: flow variations with a period of 0.5 seconds require a gate time of ≥ 0.5 seconds.

You may select intervals from 507 msec to 3042 msec in steps of 507 msec via the [↑] key. Save your selection with [E].

presets	507	1014	1521	2028	2535	3042
meaning	ms	ms	ms	ms	ms	ms
operation	[↑]	[↑]	[↑]	[↑]	[↑]	[↑]

5.5.7 *GATE-MEM* Gate Memory

This parameter determines the number of measurements which will be considered for calculating the actual measuring frequency (the response time of the measuring results depends on the gate time setting). With n > 0, the VTM calculates an average value considering the last n measurements and the actual measurement.

This way unique or rare disturbances are prevented from fully affecting the measuring results. Adaption of both parameters gate time and -memory enables for any temporary behaviour whatever.

5.5.8 *PULS-TIM*: Pulse time of divider output

In order to further process the divider output signal by additonal units (preset counters, PLC etc.) 3 different the pulse time adjustments are available:

presets	1	20	50
meaning	ms	ms	ms
operation	[↑]	[↑]	[↑]

5.5.9 *DIVIDER*: Dividing factor for the pulse output

In order to detect the flow rate with an external counter, the VTM may divide the frequency signal of the transmitter in a way the pulse output will generate a volume- or mass-proportional pulse.
You may now programme the dividing factor with a value that shall correspond to one output pulse.
Please consider the following when programming:

- The flow rate unit as per *FLOW-DIM* applies (e. g. m^3/h or l/min)
- The parameter *IMP-OUT* has to be set to *DIVIDER*
- The maxfrequency of the pulse output must not exceed 500 Hz.

Example: An external totaliser shall count integer m^3. Select m^3/min or m^3/h for *FLOW-DIM*. Enter *1.000* for the dividing factor and each output pulse will correspond to 1 m^3.

The internal totaliser of the VTM is not affected by the dividing factor.

5.5.10 *ANALOG*: Analogue output full scale

The VTM may provide a flow-proportional current signal of 4-20 mA. You may now enter the real-time value which shall correspond to 20 mA (flow rate unit according to parameter *FLOW-DIM*). For a maximum accuracy, this parameter allows for moving the decimal point independent of the adjustment for *FLOW-DP*. Press [P] to move the decimal point to the desired position. Save with [E].

5.5.11 *A-TIME*: Response time analogue output

The FAU can convert the measuring frequency into an analogue signal based on the incoming frequency (fast) or based on the »calmed« frequency (slow). The calmed frequency is calculated in accordance with the adjustments for parameters *GATE-TIME*.
Select with [↑] nd save with [E].

presets	*OUT-FAST*	*OUT-SLOW*
meaning	fast	slow
operation	[↑]	[↑]

5.5.12 *LINEAR*: Activate linearisation

This parameter can be used to either activate or deactivate the 10-point-linearisation for real-time values and analogue output. With active linearisation the VTM will correct the measuring frequency according to the programmed error and frequency figures. The programming of these figures is performed in level *LINEAR* (see page 20).

presets	*LIN OFF*	*LIN ON*
meaning	off	on
operation	[↑]	[↑]

5.5.13 *KEY-RES*: Reset via keyboard

The totaliser of the VTM may be reset via keyboard when *KEY-RES* is selected here. Select with [↑] and save with [E].

presets	*NO-RESET*	*KEY-RES*
meaning	block	allow
operation	[↑]	[↑]

5.5.14 *DIS-MODE*: Display mode in the meas. mode

For the usual measuring mode select *MESS-MOD* for this parameter which includes the real-time values (mask Q) and totals (mask V).
For start up or test purposes the *TEST-MOD* offers further measuring masks. For details see page 10. Select with [↑] and save with [E].

presets	*TEST-MOD*	*MESS-MOD*
meaning	all masks	Q- and V-mask
operation	[↑]	[↑]

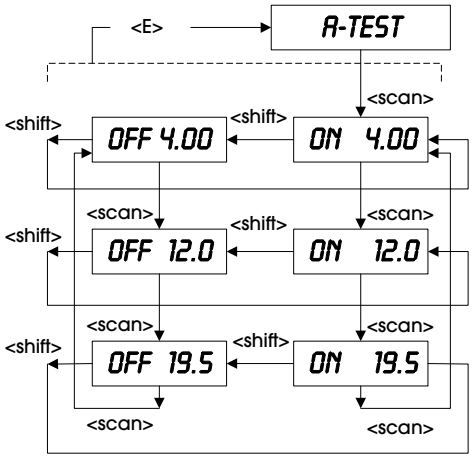
5.5.15 *IMP-OUT*: Signal source pulse output

The pulse output may either provide the transmitter frequency or volume-/mass-proportional pulses (cf. parameter *DIVIDER*). Select with [↑] and save with [E].

presets	*DIVIDER*	*M-FREQU*
meaning	divided frequency	transmitter freq.
operation	[↑]	[↑]

5.5.16 *A-TEST*: Check of the analogue output

The analogue output may be checked with respect to performance and linearity.
Three preset output values are available via keyboard.
Press [↑] to select from the presets. Via [→] (shown as **<shift>** in the diagram) you may turn the current modulation either on or off. Press [E] to quit the test.



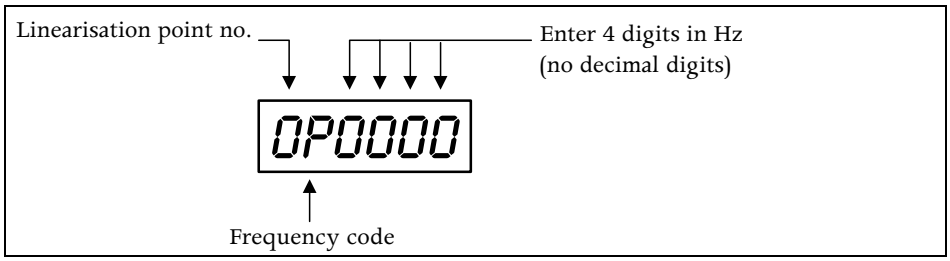
5.5.17 *CLEARMEM*: Restoring defaults

This function will restore the defaults erasing all parameter adjustments and counts. Having selected the mode via [P] the display shows *P-CLEAR* . To quit press [E]. To restore defaults press [P]. Afterwards the E with all operational parameters and counts will be erased. During this process the message * *CLEAR*/*CLEAR* * will appear in the display.

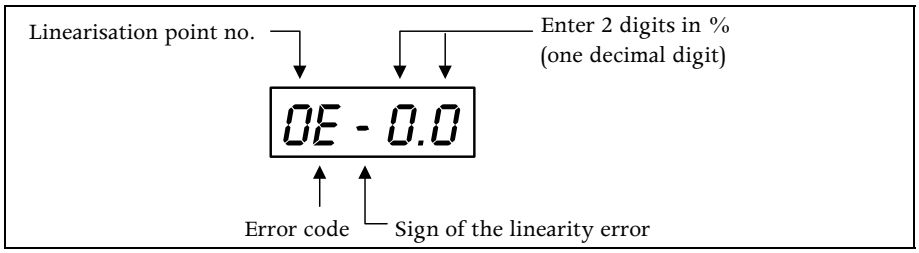
5.6 Level *LINEAR*: Linearisation

The mean K-factor of the flow meter defines a pulse rate per volume unit, which contains an error over the complete measuring range. The linearisation allows to compensate for this error by entering 10 linearisation points over the measuring range, i. e. 10 frequencies with their respective errors. This will enable you to reduce the measuring error to the repeatability which is usually ±0.1% for KEM flow meters.

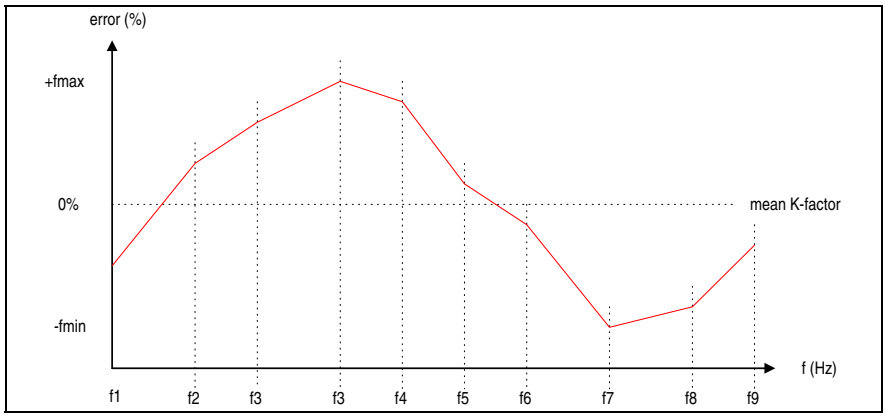
Having selected parameter level 2 press [P] to start programming the first frequency:



The programming starts off with the first frequency »0P«. You may enter the frequency figures using the [↑] and [→] key. Frequencies are to be entered as integer numbers in Hz. The figures can be found in the calibration record of the flow meter. On completion of this parameter, you are requested to enter the respective linearity error. The display shows the following:



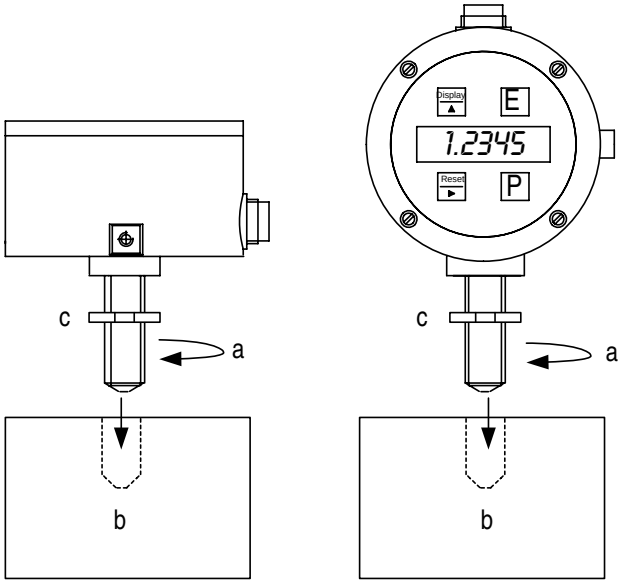
The linearisation point no. is automatically maintained. Use [P] to select the sign of the error, either + or −. Enter the linearity error with one decimal digit in 1/10% via [↑] and [→].
On completion the MCM will automatically go back to the frequency display for programming the next frequency. This process will repeat until a frequency has been programmed as 0 or when 10 linearisation points have been completed (last linearisation point no. is 9). After saving the last error the VTM goes back to the parameter level.



Calibration Diagram

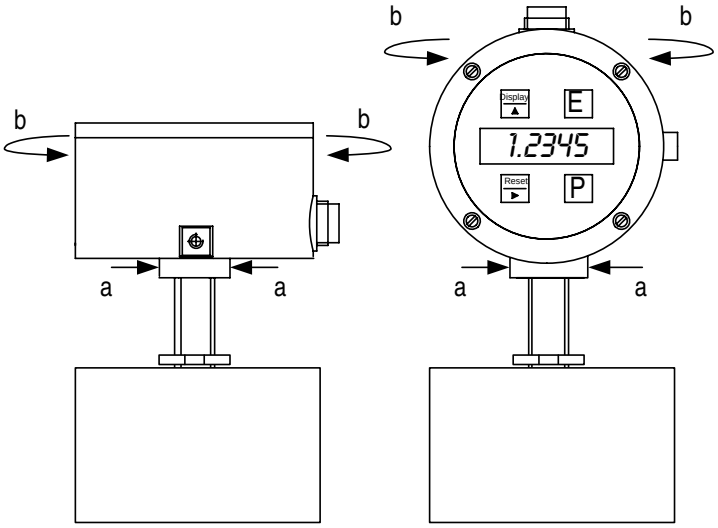
Figures for frequencies and errors can be taken from the table of the calibration record.

6. Installation



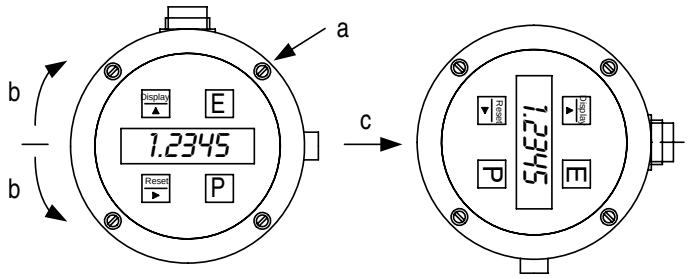
6.1 Installation on flow meter

1. Screw the VTM (a) hand tight into the flow meter (b) without using force. Be careful not to damage the sensor tip.
2. Slacken VTM by 1/4 turn to avoid metallic contact between pickup tip and the bottom of the pickup bore.
3. Tighten the locknut (c).



6.2 Positioning of the VTM housing

1. Slacken grub screws (a).
2. Move housing to the desired position (b).
3. Tighten grub screws.



6.3 Positioning the display

1. Unscrew the four fixing screws (a).
2. Remove the top and turn it in any direction (b) you like in steps of 90° (c).
   Please ensure the supply core is not twisted by more than 270°.
3. Put on the top and screw in the fixing screws.